C-12

Temperature dependence of magneto-electric properties of magnetic tunnel junctions with Al_2O_3 insulating layer

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Temperature dependence of tunneling magneto-resistance (TMR), junction resistance and exchange bias for the magnetic tunnel junctions (MTJs) fabricated in various oxidation conditions by surface plasmon resonance spectroscopy (SPRS) was studied. These MTJ samples have bottom- pinned layer structure. The layer structure of MTJ is typical structure, such as Ta / NiFe / IrMn / CoFe / Al_2O_3 / CoFe / Ta. The junction resistance increases when the temperature decreases for samples. In case of the optimal MTJ, at room temperature, the MTJ' s resistance in parallel state (R_P) is 1299.7 Ω and the resistance in anti-parallel state (R_{AP}) is 1728.9 Ω; at 10 K, R_P and R_{AP} increase to 4672.9 Ω and 5401.9 Ω, respectively. By computing the TMR ratio by $[(R_{AP} - R_{AP}) / R_P]$, we obtained the temperature dependence of TMR ratio for the MTJ from 10 to 300 K. The TMR ratio is 33.02 % at room temperature. Before the temperature decrease to about 150 K, the TMR ratio increase to 37.55 %. As the temperature decrease more, the TMR ratio decrease to 15.6 % at 10 K. This result was corresponded with the other' s results. Also, exchange bias has temperature dependence. The exchange bias increases when the temperature decreases for samples. Before the temperature decreases to about 50 K, the exchange bias increases gradually. Below 50 K, exchange bias increases all of a sudden. Then, we investigated variation of magnetization at low temperature by SQUID.